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ABSTRACT

A study was conducted to examine the effects of prescribing the use of some specific reading strategies on comprehension. The effects of such prescription on the interactions among instructional method and a number of individual difference variables were also investigated. Subjects were 140 high school students randomly assigned to read a text passage displayed on microcomputers in one of four conditions: (1) required review of main text if response to adjunct questions was incorrect; (2) required review of an alternate, easier text if the response to adjunct questions was incorrect; (3) optional review; and (4) reading without adjunct questions. In each of the conditions students also had access to a number of other macroprocessing options. Pretests and posttests were also administered, including the Nelson-Denny reading test, a worry-emotionality scale, a test anxiety scale, and a scale assessing prior knowledge of the topic in the reading passages. The results indicated that the required review groups outperformed the others on text relevant to the adjunct questions, and also differed significantly from the other groups in the number of reviews. Significant interactions among treatment, prior achievement, and anxiety measures were also obtained. Students' self-report of reading strategies were found to be unrelated to options use. (Tables of data, a copy of the reading habits scale, and a 4-page list of references are included.) (HTH)

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TECHNICAL REPORT

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OPTIONAL AND REQUIRED TEXT REVIEW STRATEGIES AND THEIR INTERACTION WITH STUDENT CHARACTERISTICS.

SIGMUND TOBIAS

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INSTRUCTIONAL RESEARCH PROJECT

CITY COLLEGE OF NEW YORK

CS008101

SUMMARY

A total of 140 students was randomly assigned to read a text passage displayed on microcomputers in one of four conditions: 1) Required review of main text if response to adjunct questions was incorrect. 2) Required review of an alternate, easier text if the response to adjunct questions was incorrect. 3) Optional review. 4) Read-only without adjunct questions. In each of the conditions students also had access to a number of other macroprocessing options. The results indicated that the required review groups outperformed the others on text relevant to the adjunct questions and, also differed significantly from the other groups in the number of reviews. Significant interactions among treatment, prior achievement and anxiety measures were also obtained. Students' self-report of reading strategies were found to be unrelated to options use. The results are discussed in terms of students' knowledge of useful reading activities.

Introduction

Recent research has indicated that readers engage in less strategic behavior than expected. Evidence from a number of areas has also suggested that reader's use of strategies has been fairly inconsistent, often ineffective, and unrelated to various student characteristics. The purpose of this study was to examine the effects of prescribing the use of some reading strategies on comprehension. The effect of such prescription on the interactions among instructional method and a number of individual difference variables were also investigated.

Review of the Literature

In a preceding study (Tobias, 1984a) a variety of reading strategies including review, taking notes, consulting an easier passage, and others were available to students reading a passage dealing with data processing that was displayed on microcomputers. Students could invoke these strategies as options at any time during their reading and use them as frequently as they wished; option use was monitored by microcomputer. Enormous variability in the use of instructional options was found. Standard deviations were often two and three times the size of the means, and the percent of students using any of nine options ranged from a high of 82%, to a low of 12%. Correlations between frequency of option use and posttest scores were quite low and generally non-significant, raising question as to whether options were used to improve comprehension. Finally, correlations with individual difference measures, such as reading scores, state and trait anxiety indices, or measures of prior knowledge were also found to be low.

Similar reports of inconsistent use of reading strategies have come from a number of research projects. For example, Markman (1979) examined the awareness of text inconsistencies among students in third to sixth grade and found that the majority of this group did not detect inconsistencies even when told to lookout for them. Garner and Kraus (1981-82) found that 4 out of 15 seventh grade good readers were able to detect inconsistencies between sentences. Baker and Anderson (1982) also used a similar paradigm in which students read text displayed on microcomputers. They found that only 31% of this college student sample re-read a sentence that preceded a main point inconsistency, and only 16% re-read sentences that preceded a detail inconsistency. Furthermore, 49% of their students did <u>not</u> report either one or both inconsistencies.

Infrequent use of reading strategies has also been reported in studies of student review or "lookbacks". Garner and Reis (1981) found that only 30% of seventh grade good readers looked back at prior text in order to answer questions. Only 9% of the poor readers did so. Alexander, Hare, and Garner (1984) found that for college students who were good readers only 30% looked back at preceding text and that 50% never looked back under any conditions. Their results also indicated that strategies reported by students were actually

used by them.

Hare and Smith (1982) used sixth and seventh graders to investigate reading strategies. No student reported use of more than two strategies, and a negative relationship between recall and number of strategies reported was found. Meyer, Brand, and Bluth (1980) found that good readers used text structure strategies to aid recall more frequently than poor readers. However, less than 50% of their subjects used the strategy more than once, and only 22% of their subjects used such strategies consistently on four separate protocols. Nist and Hogrebe (1984) reported ineffective use of both adjunct questions and headings among 103 college students. That is, use of these aids seemed not to have affected reading achievement.

While these findings demonstrate infrequent, variable, and ineffective use of strategies by students, other research has indicated that training students to use various strategies has been effective in improving comprehension. Palincsar and Brown (1984) found their reciprocal teaching paradigm successful in helping students acquire metacognitive strategies. Stevens (1983) reported generalization effects from a metacognitive strategies teaching program. Weinstein and Rogers (1984) developed a college-level program to teach students to monitor comprehension and use learning strategies. They reported increased scores on a standardized measure of vocabulary and reading comprehension, as well as greater retention of course material.

Garner, Hare, Alexander, Haynes, and Winograd (in press) taught remedial readers (mean age 11 years, 2 months) why, when, and where to use a lookback strategy. Testing five days after instruction indicated that students used lookbacks when needed and were significantly more accurate on lookback questions than the control group of remedial readers. Alvermann and Van Arnam (1984) found that a graphic organizer, which redirected the reader to the appropriate text in order to answer questions, facilitated the achievement of poor comprehenders.

These reports indicated that when students were either taught or prompted to employ reading strategies, use of these became more effective compared to an environment in which strategy use was left entirely to students' initiative. Therefore, it was hypothesized that learning would improve if students were required to review text when they experienced comprehension difficulties, compared to a condition in which strategy use was optional.

One of the reasons for variable and ineffective use of reading strategies may be that students are not completely aware of the strategies actually used. The options made available to students in a preceding experiment (Tobias, 1984a) were based on the results of a pilot study in which students were asked to list the reading strategies employed. With the exception of underlining, which was difficult to implement on the computers employed in the study, the most frequently listed strategies were made available to students in the experiment. Even though the pilot sample claimed to use these strategies frequently, the experimental sample generally employed

them infrequently and ineffectively. In contrast, Alexander et al. (1984) found that student reports of strategies used coincided with observer reports in most cases (17 out of 19 self-reports of lookbacks). Since text was again displayed by microcomputer in the present study, more precise data on strategy use than available to Alexander et al. could be collected. As indicated previously, student use of options was monitored by computer. These data will be compared to self-reports, in order to clarify students' awareness of their strategy use.

Adjunct Questions

It was assumed in both the preceding (Tobias, 1984a) and in the present study that one way to induce students to monitor their comprehension carefully was to ask adjunct questions about some of the material they had read. A substantial body of research (Anderson & Biddle, 1975; Rickards, 1979) has indicated that such questions improve student comprehension. It was expected that answering adjunct questions would prompt students to use a variety of reading strategies more frequently, leading to improved achievement.

The results of our prior study (Tobias, 1984a) supported the expectation that adjunct questions would result in more active processing and improved achievement. Students answering adjunct questions learned more than a read-only group and took notes more frequently, in addition to reading an alternate, easier version of the text passage more often. While a large number of studies employ adjunct questions, students are rarely permitted to review their reading in those investigations. The results of the few studies permitting review (Gustafson & Toole, 1970; Schumacher, Moses & Young, in press) indicated that achievement was increased by reviewing.

Anxiety and Achievement Treatment Interactions

This study was also stimulated by research from two other areas: 1) investigations of the effects of test anxiety on learning, and 2) ATI research, that is, studies of the interaction between individual differences and instructional treatments. Research on anxiety, summarized elsewhere (Tobias, 1984b), has indicated that anxious students are more likely to use review procedures and to benefit more from their use than those less anxious. An explanation for these findings is that review is especially beneficial to anxious students, since their attention is more frequently diverted from the task to a variety of negative self-preoccupations than is the attention of less anxious students (Wine, 1971; Sarason, 1972). Having the opportunity to review, therefore, enables anxious students to redirect their attention back to the task and thus compensate for the effects of anxiety. There is some research (Tobias, 1984b) to support this hypothesis.

ATI research assumes that no one instructional method is optimal for all types of learners. Instead, it is hypothesized that some instructional methods are ideal for some students, while others may be optimal for students with different characteristics. This

research, reviewed at length by Cronbach and Snow (1977), has been characterized by a number of problems (Tobias, 1982,1985), including lack of generality for some results, inability to replicate others, and an approximately equal number of positive and negative findings. It has been suggested (Tobias, 1982) that different instructional methods can lead to changed outcomes in two ways: 1) if students employ different cognitive processes or macroprocesses, or 2) if the same macroprocesses are used less frequently in some methods than others. In terms of the present research, then, it was expected that variation in achievement would occur only if there were differences in the frequency with which students in the various conditions employed macroprocessing options, or if they used different types of macroprocessing options.

Finally, a general ATI hypothesis (Tobias 1976, 1982) predicted that prior achievement had an inverse relationship to the amount of instructional support available in different methods. That is, students with little familiarity with an area were expected to need substantial instructional support to learn, whereas more knowledgeable students require less support. Instructional support has been defined as the assistance given to students in encoding, storing, organizing, and processing instructional input. In the present study, then, it was expected that students with low prior knowledge of a subject would use instructional support (i.e., the macroprocessing options) more frequently than those with higher prior knowledge.

Method

Students were randomly assigned to one of four groups to read an instructional passage displayed by microcomputer. Various macroprocessing options were available to students on the machine, and a posttest was administered after the passage.

Procedures

The experiment was conducted in two sessions. In the first, the following instruments were administered. 1) The Nelson-Denny Reading Test (Brown et al., 1981). 2) The Worry-Emotionality Scale (Morris, Davis, & Hutchings, 1981), with instructions for students to respond the way they felt at the moment. 3) Sarason's (1972) Test Anxiety Scale. 4) A multiple choice pretest assessing prior knowledge of the subject matter on which instruction was about to occur. Those students receiving pretest scores above 60% were excused from the second part of the investigation. 5) Some questions which required constructed responses about the student's habitual reading strategies.

In the second session, students were randomly assigned to one of four groups. 1) Adjunct Questions. In this group students received a total of 22 adjunct questions requiring constructed responses. Each question covered a preceding segment of text and was displayed after the text was erased. 2) Main review. This group was identical to the first, except that if students' answers to the adjunct questions were incorrect, they were so informed and required to

review the preceding screenful of text and respond to the question again. This procedure was repeated if the second answer was wrong. If students gave an incorrect answer the third time, a research assistant examined the response. If the answer was judged to be correct, students continued to read the succeeding text. If the response was wrong, they were required to perform one additional review. After the third reading, if the answer was still incorrect, the right response was supplied, and students continued reading. 3) Alternate Review. This group was identical to the preceding one, except the students were required to review on alternate, easier text. 4) Reading. In this group the text was presented without adjunct questions, although students were free to review alternate or main text or use any of the other options.

In each of the four groups students could use any of the following options. 1) Alternate Text. Students could consult an alternate, easier version of the text at the completion of any paragraph of the main text. Completion of the paragraph was signaled by sounding the computer's beep. 2) Notes. Students could take notes on the computer system. 3) Options Display. Students could consult a display describing each of the options. 4) Main Text Review. Students could review the main text, in addition to the required review, in two ways: a) whenever the backward arrow was pressed, the preceding sentence was displayed, and the present sentence deleted; b) students could request a range of sentences to be displayed by indicating the numbers of the beginning and ending sentences they wanted to review. 5) Alternate Text Review. Identical to the preceding option, except that the easier alternate text was reviewed. 6) Review of Notes. Students could review the notes previously taken.

It should be noted that the only time students could not review was when an adjunct question had been presented and a student response was expected. Once a response was made, review was permitted. The text material was displayed on Apple II Plus and IIe microcomputers. Delays in invoking any of the options or in proceeding from one segment to another never totaled more than 1 1/2 seconds.

All text in main, alternate, and explanatory passages was numbered and displayed one sentence at a time. When students completed a sentence and pressed the space bar, it was erased, and the succeeding sentence displayed. The number of the preceding sentence remained, and the space occupied by it was left vacant so that students could easily request reviews of preceding material.

The Worry-Emotionality Scale was administered two more times. The first was on computer, when students had completed half of the text passage, with instructions to respond the way they felt at that time. A second administration occurred immediately after the posttest, with instructions to respond the way they had felt during the test.

Materials

Prior to starting on the instructional text, a preliminary passage composed of 45 sentences was displayed. This material described the options and required that students use each option at least once. This material was designed to show students how to invoke each of the options.

The text passage and adjunct questions were developed for a prior study (Tobias,1984a). It introduced students to some general concepts about data processing and computer programming and illustrated these by a few instructions from the BASIC programming language. The passage was composed of 49 paragraphs. The main version consisted of 173 sentences, with 182 sentences in the alternate version. The main version was written in a 14th grade vocabulary (Fry ,1968); the alternate version used a 10th grade vocabulary and more regularly used an organizational scheme of super-ordinate introductory sentences followed by sub-ordinate sentences than did the main passage.

The pretests and posttests were also used in the prior study (Tobias, 1984a). The pretest was composed of a 50 item multiple choice test which had an alpha reliability of .75 in the prior investigation. This test was developed in a multiple choice format in order to obtain a fine-grained measure of prior knowledge. The posttest was composed of 51 fill-in items requiring constructed responses. Two subtests were developed from the posttest. The relevant section was composed of 25 items which were similar to the adjunct questions that were interspersed throughout the text. The incidental subtest contained 26 items whose content had not been covered by adjunct questions. The alpha reliability of the incidental subtest in the prior study was .85, compared to an alpha of .76 in the present investigation. The reliabilities of the relevant subtest in the present and prior investigations were .86 and .87, respectively.

Adjunct questions requiring constructed responses were created and inserted after every screenful of text. The questions were designed to require factual responses, recall of concepts, and applications of material taught. A variety of possible correct answers, determined in the prior investigation (Tobias 1984a), were scanned by the computer to score adjunct questions. The answer set included most possible correct responses, their semantic equivalents, and emphasized correctness of the concepts by tolerating a variety of misspellings. For example, one of the required responses was the word "multiply", and among the set of acceptable answers were any responses containing the letters "mltp".

Self-Reports of Processing

Students were administered two scales pertaining to their use of reading strategies. One scale asked students to describe, in a free response format, the type of reading strategies used in a variety of situations. This questionnaire was administered before students read

the passage (see Appendix 1). After completing the posttest, students filled out a second questionnaire in which they were required to check, on a Likert-type scale, a variety of strategies they might use while studying three subjects: Computer-science or mathematics, English, and Science. The strategies to be checked for each of these subjects included: re-read, prepare summaries, take notes, review, try to find an easier description, use a dictionary, answer study questions, plus an "other" category (see Appendix 2).

Subjects

A total of 140 students served as subjects for this experiment 100 female, 40 male. The sample was recruited from a an urban high school and was composed of 91 incoming members of the freshman class: 27 sophomores, 19 juniors, and 3 seniors. Students were required to obtain parental permission to volunteer for the research and were paid $7 for their participation.

Results

The major findings of this experiment dealt with three sets of data: Effects of the different treatments, individual difference measures, and their interactions on 1) learning, as determined by the posttest, and 2) on macroprocessing options used by subjects and their relationships to posttest scores. 3) The third data set dealt with the relationships between students' self-reports of reading strategies and options employed during this study.

Posttest Results

The means and standard deviations on the relevant and incidental posttest scores obtained by the four experimental groups are displayed in Table 1.

Insert Table 1

In addition, Table 1 also shows the means and standard deviations of the different groups on the pretest, the Nelson-Denny Reading Test, and the test anxiety data.

The effects of the independent variables on the incidental and relevant posttest were analyzed by multivariate multiple regression analysis using the MANOVA program in the SPSSx Package (SPSSx,1983). In order to reduce the effects of co-linearity, scores on continuous variables, such as pretest and test anxiety, were converted to average deviations, as recommended by Cronbach and Snow (1977). The results of that analysis and the univariate results for both incidental and relevant posttest are displayed in Table 2. (See Appendix 3 for the regression coefficients for these effects).

Insert Table 2

There were significant multivariate differences on posttest among the treatment groups. Univariate analyses indicated that this effect was largely attributable to differences on the relevant part of the posttest. The means, displayed in Table 1, indicated that the required review groups had significantly higher scores than both the optional review group and the group reading the text without adjunct questions. Pretest exerted a significant effect on posttest. Students with higher pretest scores out-performed lower scoring students. There was also a significant interaction among treatment, pretest, and worry on relevant posttest scores. The regression surfaces for three treatment groups were similar, except for the group required to review the alternate text. In that group, as students pretest score increased and worry decreased, scores on the relevant posttest increased sharply.

Macroprocessing Options

The number of times students in the different groups used the various macroprocessing options is shown in Table 3, which also

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Insert Table 3
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displays the correlation of each macroprocessing option with total posttest score.

The effects of treatment, pretest, anxiety, and their interactions on the macroprocessing options were determined by computing a multivariate multiple regression analysis. The results of that analysis and of the univariate analyses on each of the dependent variables are displayed on Table 4.

Insert Table 4

The results indicated that there was a significant multivariate effect for treatment on all of the dependent variables and that there were significant interactions among both treatment and pretest scores, as well as worry and treatment. (See Appendix 4 for the regression coefficients for all effects in this analysis.)

There were highly significant univariate effects for both the number of main and the number of alternate sentences reviewed. Table 3 indicates that the group required to review the main text reviewed 5 to 30 times more sentences, compared to any of the other groups. Furthermore, the alternate review group reviewed about 20 times more alternate sentences than any of the other groups. There were no significant univariate differences for any of the other macroprocessing options, indicating that the multivariate effect was

largely attributable to reviews of main and alternate texts. The univariate results indicated that students with higher pretest scores reviewed significantly fewer alternate sentences than low scoring students, and worried subjects reviewed more alternate sentences than their less worried peers.

The univariate analyses also indicated a number significant interactions. These are displayed in Figures 1-3.

Insert Figures 1-3 here

Relationship Between Option Use and Strategies

A content analysis of students' answers to the free response scale asking about their reading strategies was conducted, and answers were clustered into categories. A multivariate analysis of variance was then computed in which the independent variables were the response categories, and the dependent variable consisted of the number of sentences on which options were actually used in this experiment.

The first question, the categories of student answers to the question, and the number of students per category are shown in Table 5.

Insert Table 5

The multivariate analysis of variance yielded a Wilk's lambda of .85 for this analysis, which was not significant. The univariate results indicated that none of the differences among the groups on any of the macroprocessing options was significant.

The second question and the number of students giving different categories of answers to the question are displayed in Table 6.

Insert Table 6

The significance of differences in actual use of macroprocessing options among the groups shown in Table 6 were examined by multivariate analysis of variance; Wilk's lambda was .80, which was also not significant. In the univariate analyses, the only significant difference among the groups was on the frequency with which the options menu was inspected. This comparison indicated that students reporting that they mark or underline text used the options menu more frequently than any other group.

The third question and the number of students in each of the response categories are displayed in Table 7.

Insert Table 7

The multivariate analysis of variance for differences among these groups on strategies actually used yielded a Wilk's lambda of .88, which was not significant. Again, univariate analyses for the various strategies were not significant, with the exception of the frequency with which the options menu was consulted. The group which indicated that they would use a variety of study techniques inspected the options menu more frequently than any of the other groups.

The fourth question asked: "When you are reading and find a word that you don't understand which of these do you do ? You may check more than one". The choices offered included: A. Try to figure it out from the sentence. B. Ask someone for help. C.Look at a dictionary. D. Skip it and continue reading. F. Other. Please specify. Since students could pick more than one choice in answer to this question, responses were also grouped into categories which are displayed in Table 8.

Insert Table 8

The multivariate analysis of variance for differences among these groups resulted in a nonsignificant Wilk's lambda of .92. The univariate analyses of differences among the groups on each of the options indicated that there were no significant differences on any of these options.

Student responses on the Likert-type scales regarding the reading strategies they would use in various areas, administered in the first session of the study, were then correlated with utilization of similar strategies in this study. Two analyses were computed. In the first, the responses to all questions in each area were added. That is, students' overall responses in computer-science or mathematics, English, and science were added to yield a total score, and these three scores were then correlated with option use in this experiment. This analysis identified only one significant correlation of -.20 between the total score reflecting all the strategies used in English and frequency with which students took notes. None of the other correlations were significant.

Relationships were also examined between student self-reports of strategy use and employment of similar options in this study. For example, students were asked to note how frequently they took notes, how frequently they tried to find an easier description, and how frequently they re-read or reviewed. Responses to each of these questions were then correlated with note taking, use of alternate text, and reviews in this study. None of these correlations was significant.

Discussion

The findings of this study indicated that students who were required to review preceding text when their answers to adjunct questions were incorrect obtained significantly higher scores on that portion of the posttest related to the adjunct questions. Pretest score contributed significantly to overall posttests scores, and there were significant interactions among experimental conditions, pretest, and test anxiety. There were highly significant differences among the groups in option use, principally on the number of sentences reviewed, in addition to a number of significant interactions for these data. Finally, there was little relationship between students' self-reports of reading strategies and option use. These results will be discussed below, and their implications for further research suggested.

Macroprocessing and Achievement

The higher achievement of those required to review had been predicted. In these conditions, students had to re-read preceding main or alternate text if they answered an adjunct question incorrectly. It seemed clear that these groups did not learn more about the text in general, since there were no differences on that part of the posttest which was unrelated to adjunct questions. Apparently, students required to review skimmed preceding text for content relevant to the adjunct questions rather than carefully re-reading all of the material on the prior screenful. Those not required to re-read, that is, optional review and read-only groups, had higher (though not significantly so) scores on the incidental portion of the posttest. This finding strengthened the interpretation that while reviewing, students attended mainly to portions of the posttest which were relevant to the adjunct questions, otherwise their scores on the incidental posttest would have increased as well.

The interaction among treatment and pretest on the number of sentences of alternate text read (see Figure 4) is of some interest. It should be noted that these data describe the number of sentences in alternate text that were consulted while reading the main passage, irrespective of reviews. The interaction suggested that as pretest score increased, the number of alternate sentences read by both mandatory review groups increased. On the other hand, the number of alternate sentences read decreased as pretest score increased for the optional review and read-only groups. It seemed that more knowledgeable students, determined by higher pretest score, developed the following preventative strategy: They read the easier text when comprehension difficulty occurred in order to ensure that they would be able to answer the ensuing adjunct question correctly and avoid a required review.

The interaction among pretest and treatment on number of main text sentences reviewed (see Figure 2) indicated that in the group required to re-read main text, students with high pretest scores

reviewed slightly fewer sentences than those with lower pretest scores. For all other groups the number of sentences reviewed increased as pretest score went up. Apparently, more knowledgeable students made fewer errors on the adjunct questions and hence had to review fewer main text sentences than those with less prior knowledge. Especially remarkable (see Figure 2) were the large differences between the groups. It will be noted that those required to review main text re-inspected a mean of 100 sentences, whereas all of other groups reviewed less than 20.

The two interactions involving anxiety indicated that as worry (a component of test anxiety) increased, the number of sentences students had to review also went up. These findings were in accord with much other research relating anxiety to errors (Sarason, 1980) and indicated that more anxious individuals made more mistakes on adjunct questions and therefore were required to review more sentences. For the groups who did not have to review main text, the interaction function had an essentially flat slope. It seemed that anxious students in these groups did not voluntarily review main text more often, as had been expected from prior research (Tobias, in press). Presumably, these results are attributable to problems with students' use of reading strategies, to be discussed below.

The results indicated that there were significant overall differences among the groups in the frequency with which macroprocessing options were used. This finding was a function of differences in the number of main or alternate sentences students were required to review. Univariate results indicated that none of the differences among groups in their use of other options approached significance. Apparently, being required to review was the only factor inducing students to use the macroprocessing options differentially.

Correlations between number of sentences re-examined and posttest scores were -.55 for those required to review main text and -.62 for the alternate review group, both significant beyond the .01 level. These correlations suggested that students who made errors on the adjunct questions and were forced to review earned lower posttest scores than those with fewer mistakes, who reviewed less often. Since the required review groups outperformed the others on the relevant portion of the posttest, it can be inferred that if students who had difficulty with the text did not have to review, their scores on the posttest may well have been even lower. This interpretation is strengthened by the correlations between the number of reviews and pretest scores for groups required to re-read: -.43 ($p < .01$) for those required to re-read alternate text and -.27 for the main text review group. Knowledgeable students were required to review less frequently than those with less familiarity with the subject, and they achieved higher posttest scores, as can be seen from the correlation of .55 ($p < .001$) between pretest and posttest for all groups combined.

Option Use: Self-Report and Actual

There was little relationship between student self-report of reading strategies and use of similar macroprocessing options in this study. These results conflict with those reported by Alexander et al. (1984), who found that students who reported using strategies did so. The differences in the results of these studies could be attributed to the way strategy use was determined. In this experiment option use data were recorded by computer, generating a precise and relatively fine-grained measure specifying the number of sentences involved in option use. Alexander et al.'s data were obtained by observing the behavior of readers and were recorded in terms of total number of "lookbacks" or reviews.

It has been noted that students read the text selection on microcomputers. Some aspects of this situation were different from students' usual reading. That is, material was exposed one sentence at a time, sentences were deleted when students signaled that they had finished them, whereupon the succeeding sentence was displayed. It is possible that this presentation and the use of cathode ray tube screens for text display made the situation somewhat more artificial than the usual reading tasks encountered by students. The absence of relationships between student reports of strategy use and actual use may possibly be attributed to these factors. Since both self-report measures of strategy use employed in this study were not specific to the computer administered reading task, it remains for further research to clarify this possibility.

A further reason for inconsistent and ineffective use of strategies may be that students may not know how to use strategies to improve their learning. Since students are rarely instructed in the use of cognitive strategies to help them learn more effectively, they probably use those processes that they think are useful. Unfortunately, such thinking may often be based on faulty or vague information, such as test outcomes. Students' test scores may be a function of variables other than processes used, including the time spent studying, their prior knowledge of the subject, and the quality of instruction, among other possibilities. Furthermore, reports of test results are rarely specific enough to give useful feedback regarding areas mastered by students, and content on which further work is required. It is difficult to relate test outcomes to strategy use in the absence of such diagnostic information. Finally, feedback regarding examination results is generally given many days after studying, adding further difficulties to students' attempts to determine which strategies were most useful.

In the absence of either instruction or adequate information regarding effective strategies, one can assume that students' use of cognitive strategies is similar to "superstitious" behavior (
), in which chance reinforcement coincides with some actions, leading to their repetition. The low correlations between number of reviews and posttest scores for the groups not required to re-read (.18 for optional review and -.18 for the reading group) strengthen this possibility. Similarly, taking notes had a correlation of .05 with posttest for all groups combined. These correlations suggested that

voluntary option use was ineffective in improving learning.

Whatever the reasons for these results, there was little relationship between student reports and option use in this study. As mentioned above, in a prior study (Tobias, 1984a) student use of reading strategies was found to be extremely variable and ineffective. If students do not have a clear idea of how intensively they use various strategies in this situation, then it is not surprising that strategy use was unrelated to outcomes or to various student characteristics.

General Discussion

Some of the results in both the present and prior investigation were paradoxical. A good deal of evidence indicated that strategies are used variably and ineffectively. In this study, even though required review did improve learning, the fact that students in these conditions reread approximately 10 to 20 times more sentences than others indicated that this was hardly an efficient process. On the other hand, there was also evidence of strategic behavior. For example, Figure 4 indicates that knowledgeable students in required review groups apparently developed a preventative strategy. They more frequently inspected the easier, alternate text prior to answering adjunct question than those with lower pretest scores. This strategy made it less likely that students might give wrong answers to the adjunct questions and be required to review. Similar strategic behavior was suggested by the triple interaction on relevant posttest and by the evidence of skimming for the right answer.

The paradox between variable and ineffective behavior on the one hand and relatively strategic behavior on the other may be explained by the ambiguity and vagueness regarding what understanding means to students. One can hypothesize that it is difficult for students to determine when they have mastery of a passage because the internal representation of a new subject may be relatively undifferentiated. That is, students may not have a specific strategy to determine whether they understand a passage, especially when the subject matter is new to them. However, when a clear-cut goal is available, such as being required to review in order to answer a question or avoiding such a review by reading the alternate passage, strategic behavior quickly becomes evident. In the absence of such a clear goal, variable and ineffective use of strategies appears to occur.

These results suggest a hypothesis. When students are given an explicit criterion against which to assess their comprehension, reading will become more strategic, compared to a condition in which criteria are more ambiguous. Strategic reading should, in turn, be accompanied by improved comprehension. We expect to test this hypothesis by varying the explicitness of the comprehension criteria available to students. It can further be predicted from ATI research (Tobias, 1982) that the more explicit the criterion, the better the performance of students with limited prior knowledge and poor reading skills. Knowledgeable students, or good readers are not expected to profit as much from explicit criteria since they are likely to use

their own implicit criteria. Furthermore, with explicit criteria review will generally be more efficient, that is, a smaller number of sentences will be re-read, than in the absence of such criteria.

The results were equivocal regarding the interaction between prior knowledge and use of options. It had been expected that knowledgeable students would use less instructional support than students less familiar with the content. While this pattern was seen in some of the interactionss, it was not the case in others. These data suggest that there is considerable inconsistency in the use of instructional support, and further research is required to clarify the characteristics of options that can be expected to be used more heavily by those with limited prior knowledge to improve their preformance. Clearly, the results suggest that the mere presence of different forms of instructional support does not guarantee that less knowledgeable students will use them frequently.

The findings from metacognitive training studies (Palinscar & Brown, 1984; Stevens, 1983) suggested that less able students must be taught to use strategies in order to use them effectively. These findings imply that if students with limited prior experience with a subject use instructional support ineffectively, they may need to be taught to use available assistance to improve their learning, whereas knowledgeable students apparently are able to use such support without special instruction. The hypothesis (Tobias, 1982) predicting that less knowledgable students will profit more from instructional support than those who mare more familiar with a subject will, then have to account for students' ability to use available forms of assistance. The predicted relationship may be expected to apply only when students can use the support effectively, or when they are prompted or taught to use the assistance.

Worry, a component of test anxiety, was positively related to number of reviews for all groups, confirming similar findings in prior research (Tobias, 1984b). That result appeared largely attributable to the groups required to review, since the interactions did not give any evidence of such relationships for the conditions in which review was optional. These results may be caused by the problems, described above, in students' use of review and other strategies. When students have clear criteria against which to assess their comprehension and are aware that review can improve their comprehension, it is expected that more anxious students will review more often and profit more from such reviews than their less anxious counterparts.

Table 1. Means and Standard Deviations of Selected Dependent and Independent Variables

		Main Review (M=25, F=10)	Alternate Review (M=29, F=6)	Optional Review (M=25, F=12)	Read Only (M=21, F=12)
Achievement Variables					
Posttest Relevant Score	Mean	14.2	13.12	11.6	10.35
	SD	4.78	5.97	5.43	5.3
Posttest Incidental Score	Mean	8.1	7.7	9.0	9.0
	SD	3.9	4.39	4.1	3.7
Posttest Total Score	Mean	22.3	20.8	20.6	19.3
	SD	8.26	9.94	9.10	8.7
Reading and Pretest Scores *					
Pretest Total Score	Mean	19.51	17.82	19.1	19.8
	SD	4.85	5.23	4.9	5.5
Nelson Denny Reading	Mean	34.03	34.45	35.83	35.1
	SD	11.03	14.85	11.95	11.7
Nelson Denny Comprehension	Mean	33.25	30.97	34.97	33.8
	SD	11.3	18.51	10.10	10.3
Nelson Denny Total	Mean	67.28	65.42	70.8	68.9
	SD	20.37	25.36	20.72	19.7
Anxiety Measures					
Test Anxiety Scale	Mean	19.45	18.08	17.81	17.6
	SD	5.30	7.57	5.55	5.4
Worry scale before reading	Mean	8.9	8.17	8.1	7.39
	SD	3.8	3.92	3.4	3.5
Worry scale during reading	Mean	8.6	9.37	9.7	7.96
	SD	3.2	4.6	4.8	3.2
Worry scale after reading	Mean	9.6	9.25	10.0	9.7
	SD	3.9	4.8	4.9	4.4

* Raw Score

TABLE 2. Multivariate and Univariate Results of Posttest.

Independent Variables	Wilks Lambda	Univariate Results POSTTEST Incidental	Relevant
Treatment (TRT)	8.95**	1.29	4.84**
Pretest (Pre)	32.14**	55.04**	57.56**
WPOST	1.81	3.86	3.42
PRE X WPOST	<1	<1	<1
TRT X WPOST	<1	<1	<1
TRT * PRE	<1	<1	<1
PRE X WPOST X TRT	1.94	2.49	3.15*

** p. <.01

* p. <.05

Table 3. Means, Standard Deviations and Correlations with Posttest for Option Use Data.

		Main Review	Alternate Review	Optional Review	Read Only
Option Use Data					
Main Text Reviews[1]					
	M	100.51	3.05	12.32	17.57
	SD	39.76	3.80	15.46	16.39
	r	-.55**	.26	.18	.22
Alternate Text Reviews[1]					
	M	3.12	122.61	5.47	4.98
	SD	8.78	51.54	10.54	7.85
	r	.08	-.62**	.22	-.18
Inspection of Alternate Text[1]					
	M	28.51	27.21	19.48	22.68
	SD	48.80	44.13	35.88	36.35
	r	.32	.26	.14	-.27
Notes					
	M	5.68	7.02	7.35	8.48
	SD	10.72	8.45	11.27	9.32
	r	.10	.04	.11	.02
Review of Notes					
	M	.39	.76	.73	1.35
	SD	1.41	1.74	1.72	1.87
	r	.05	0.00	-.08	-.06
Options Menu					
	M	1.55	.97	1.10	1.84
	SD	2.08	1.93	2.01	2.73
	r	-.04	-.05	.28	-.06

[1] Number of sentences.

** p. <.01

Table 4. Multivariate and Univariate Analyses of Variance of Option Utilization Data.

		Options					
	Wilks Lambda	Main Text Reviews	Alternate Text Reviews	No. of Sentences Alternate Text	Notes	Review of Notes	Options Menu
Independent Variables							
Treatment (T)	43.24**	143.38**	220.79**	<1	<1	1.96	1.19
Pretest (Pre)	1.83	<1	7.85**	<1	1.14	1.53	2.45
Worry (W)	2.08	<1	8.24**	2.45	<1	<1	<1
T * Pre	2.32**	3.34*	1.18	3.81*	<1	<1	2.34
T * W	2.77**	2.88*	10.26**	<1	<1	2.08	<1
Pre * W	1.68	<1	<1	<1	1.24	6.35**	5.02*
Trt * Pre * W	<1	<1	1.29	<1	<1	1.17	<1

** p. <.01
* p. <.05

Table 5. Responses to question: "What do you do when you are confused about what you are reading?"

Category	n	%
Reread	55	41
Ask for help or do nothing	25	19
Figure out meaning	31	23
Ask for help or reread	22	16
Missing data	7	

Table 6. Responses to question: "When there is something you want to remember while reading, what do you do?"

Category	n	%
Reread, rephrase, or repeat to themselves	21	15
Write it down or take notes	49	36
Mark down or underline	10	7
Miscellaneous	24	17
Taking notes with other options	32	23

Table 7. Responses to question: "While reading, what do you do when come across something that you think will be on a test?"

Category	n	%
Reread	9	7
Write down or take notes	40	31
Various techniques	39	30
Write down and use various techniques	40	31

Table 8. Responses to question: "When you are reading and find a word that you don't understand which of these do you do?"

Category	n	%
Try to figure out with various techniques	50	58
Seek help or actively solve problem	67	77
Miscellaneous	19	22

Legend of Figures

Figure 1. Interaction among treatment and pretest on main text review.

Figure 2. Interaction among worry and treatment on main text review.

Figure 3. Interaction among worry and treatment on alternate text review.

Figure 4. Interaction among pretest and treatment on alternate text use.

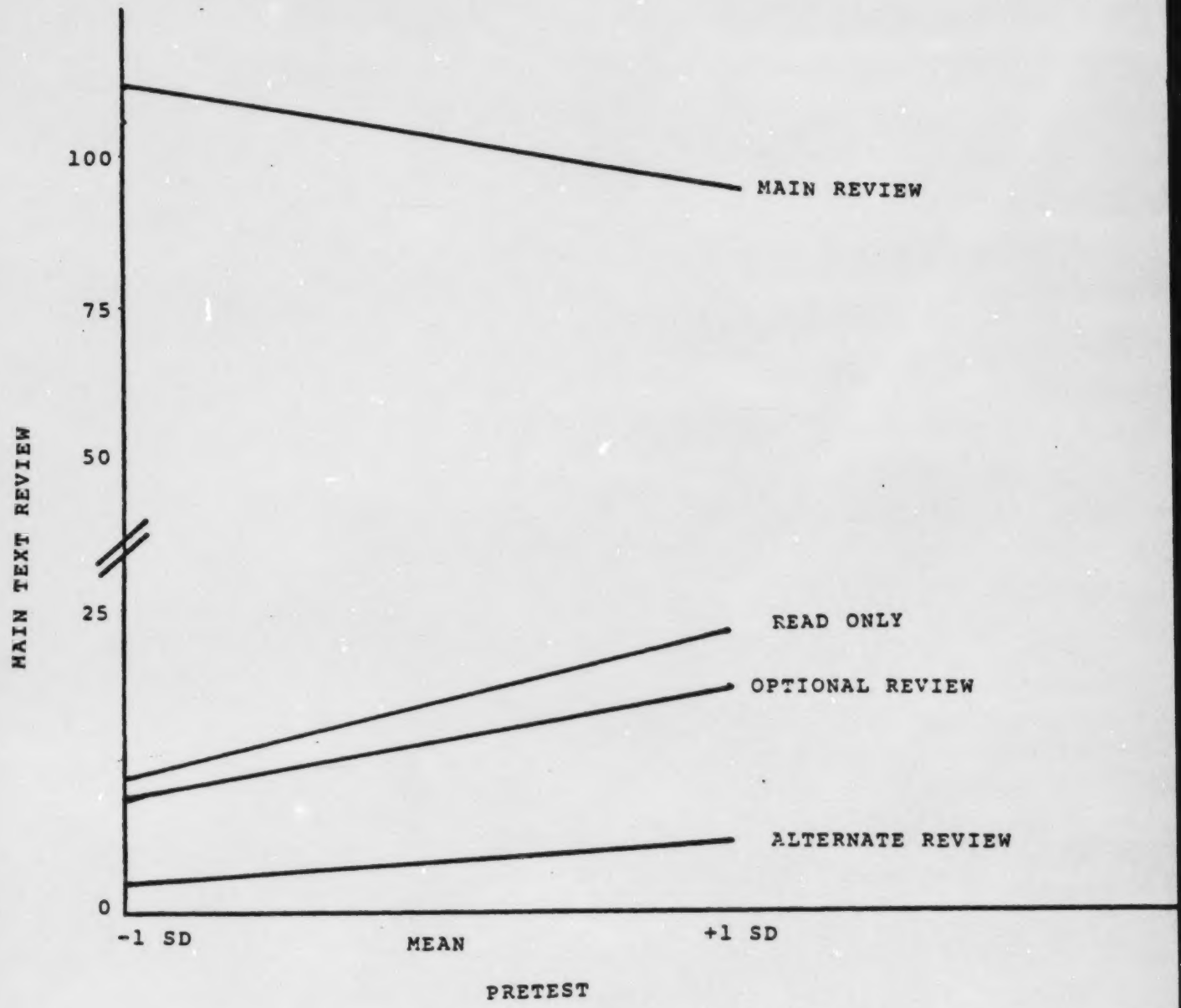
MAIN TEXT REVIEW
100
75
50
25
0
MAIN REVIEW
READ ONLY
OPTIONAL REVIEW
ALTERNATE REVIEW
-1 SD
MEAN
+1 SD
PRETEST

FIGURE 1.

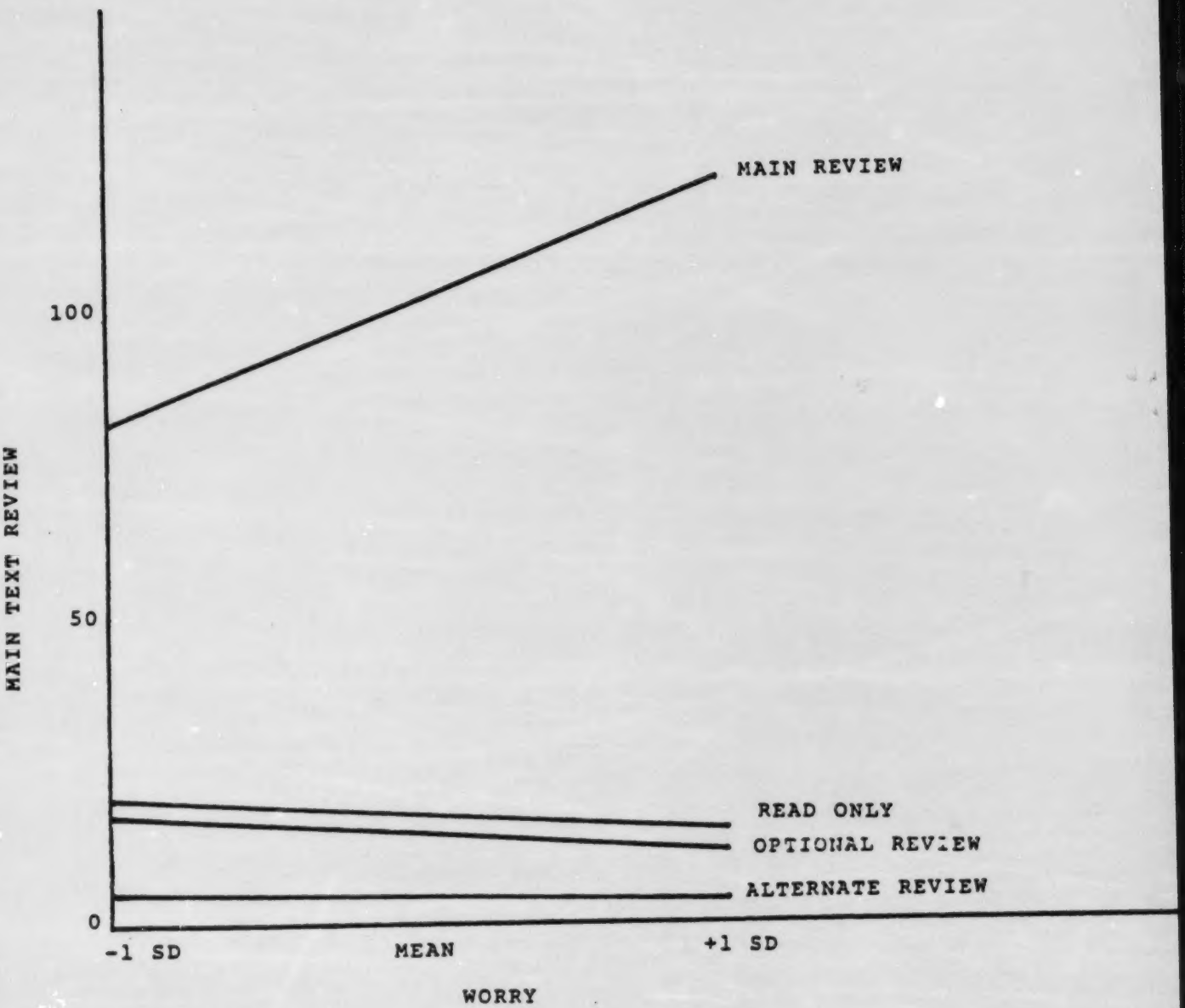
MAIN REVIEW
100
MAIN TEXT REVIEW
50
READ ONLY
OPTIONAL REVIEW
ALTERNATE REVIEW
0
-1 SD
MEAN
+1 SD
WORRY

FIGURE 2.

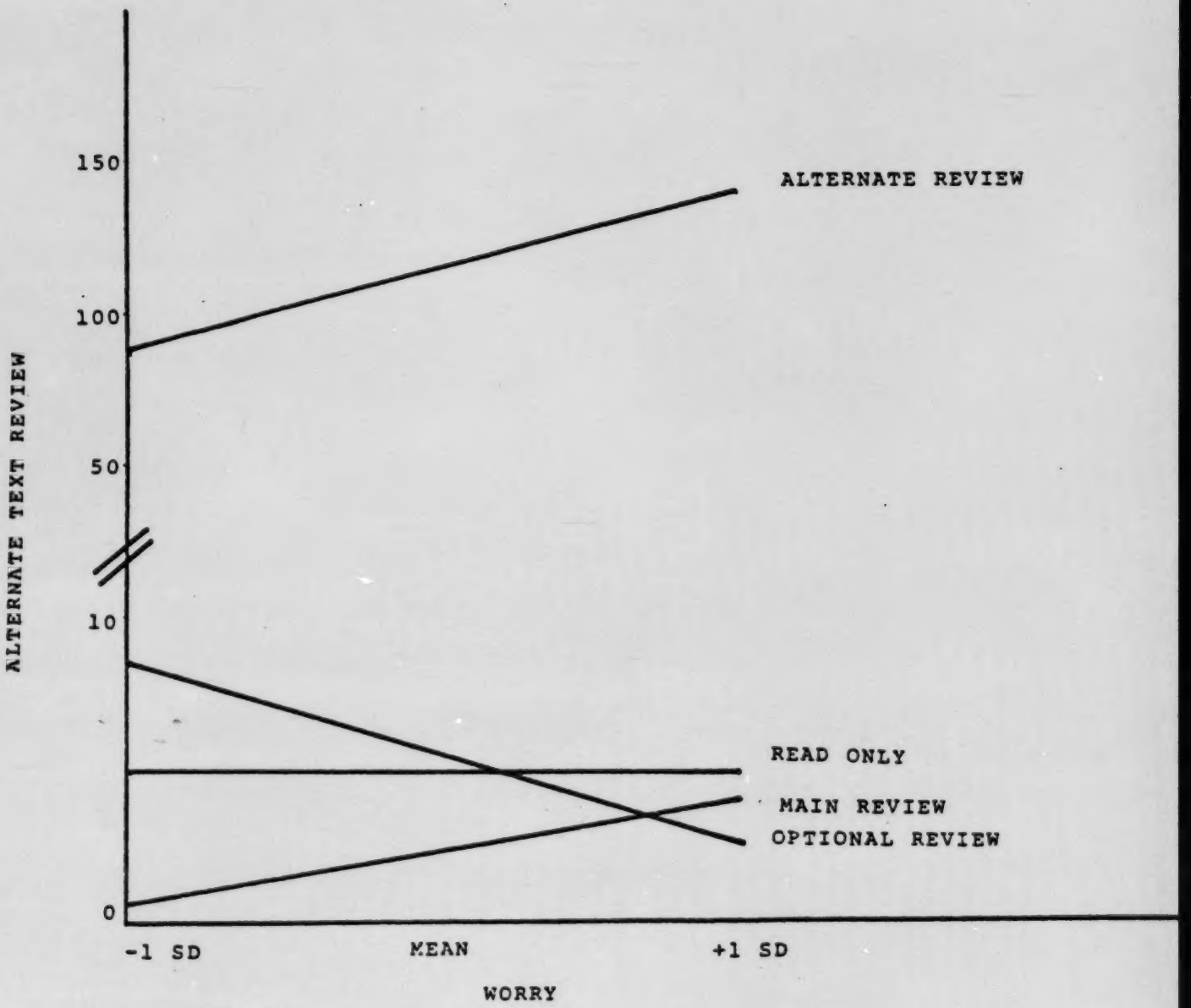
150
100
50
10
0
ALTERNATE TEXT REVIEW
ALTERNATE REVIEW
READ ONLY
MAIN REVIEW
OPTIONAL REVIEW
-1 SD
MEAN
+1 SD
WORRY

FIGURE 3.

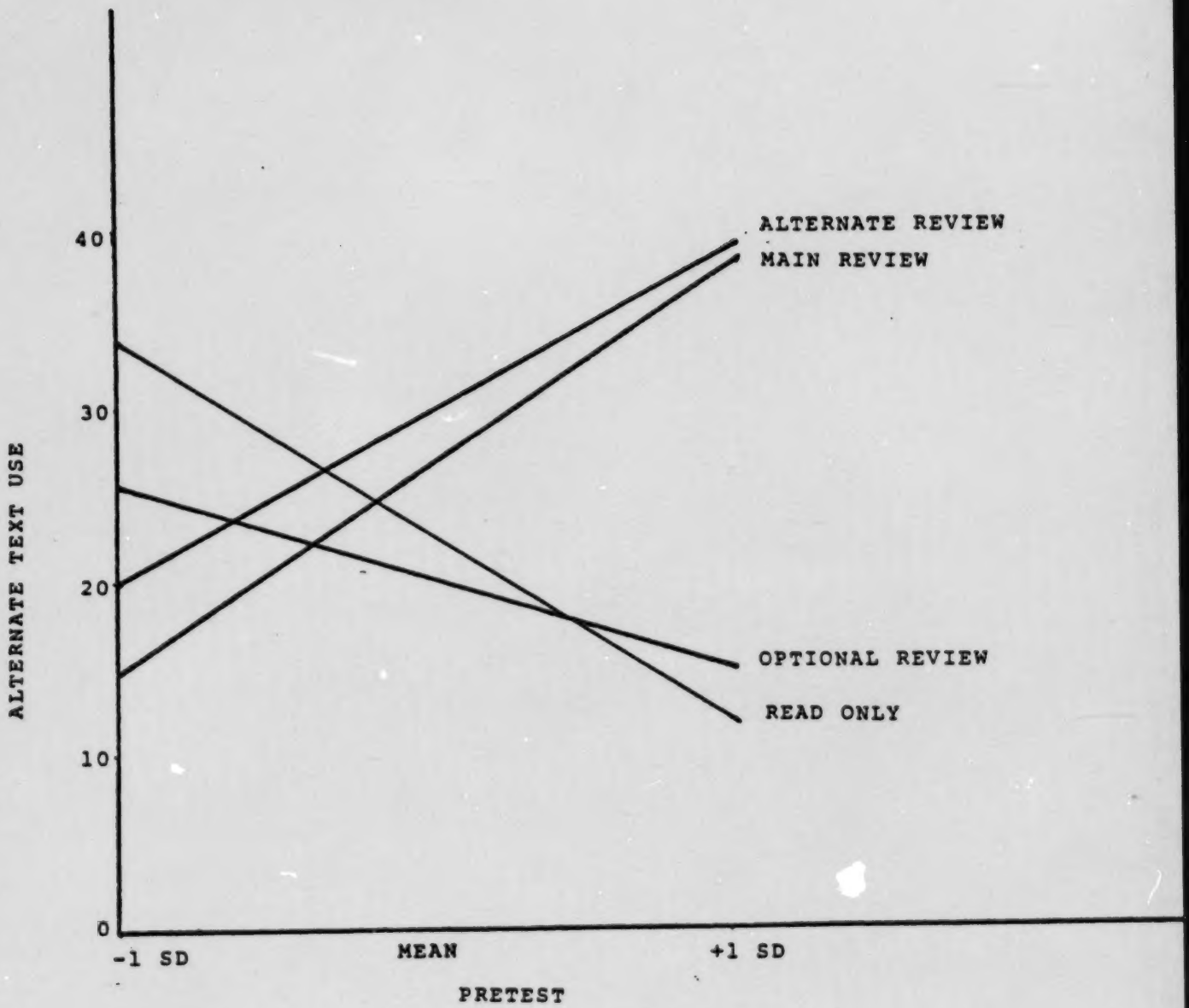
ALTERNATE REVIEW
MAIN REVIEW
OPTIONAL REVIEW
READ ONLY
ALTERNATE TEXT USE
40
30
20
10
0
-1 SD
MEAN
+1 SD
PRETEST

FIGURE 4.

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Appendix 1.

Reading Habits Scale

1. What do you do when you are confused about what you are reading? (Turn over if you need more space)

_____

_____

_____

2. When there is something you want to remember while reading, what do you do? (Turn over if you need more space)

_____

_____

_____

3. While reading, what do you do when you come across something that you think will be on a test? (Turn over if you need more space)

_____

_____

_____

Check your answer in the spaces provided.

4. When you are reading and find a word that you don't understand which of these do you do? You may check more than one.

_____ a) Try to figure it out from the sentence.

_____ b) Ask somebody for help.

_____ c) Look at a dictionary.

_____ d) Skip it and continue reading.

_____ e) Other Please specify. _____

_____

5. How often do you reread a sentence you have read before

_____ a) Very often.

_____ b) Often.

_____ c) Sometimes.

_____ d) Rarely.

6. Compared to other students how often do you take notes

_____ a) Very often.

_____ b) Often.

_____ c) Sometimes.

_____ d) Rarely.

7. Please rate your reading ability:

_____ a) Excellent.

_____ b) Very Good.

_____ c) Average.

_____ d) Below average.

_____ e) Poor.

Appendix 2.

Attitude Survey

ID# _____ Name _____

Please pick the choice that best describes your feelings in the space provided.

_____ Think of the material you have just completed. Please estimate how much of it you have mastered.
1. 1/4. 3. 3/4.
2. 1/2. 4. all of it.

_____ How did you feel about the way the material was presented?
1. Enjoyed Presentation. 3. Presentation unpleasant.
2. Presentation moderately pleasant. 4. Disliked presentation.

_____ Did you find yourself trying to get through the material, rather than trying to learn?
1. All of the time. 3. Some of the time.
2. Most of the time. 4. Never.

_____ Would you like to learn other material in a similar format?
1. Definitely. 3. Probably not.
2. Probably. 4. Definitely not.

_____ Would you prefer reading the same material in a textbook?
1. Definitely. 3. Probably not.
2. Probably. 4. Definitely not.

_____ How did you feel about the options provided on the computer?
1. Very helpful. 3. Somewhat helpful.
2. Helpful. 4. Not too helpful.

_____ On a test of what you have just read what grade would you expect?
1. A 2. B 3. C 4. D 5. F

_____ Once you got used to them, the options were:
1. very easy to use. 3. difficult to use.
2. easy to use. 4. very difficult to use.

_____ Were there other options you would have liked to have? Please list them below.

_____

_____

_____

_____

_____

Below are a number of strategies used by students while reading. Please indicate how often you use each of these strategies in different subjects, such as in computer science or math, English literature or in science.

In computer science or mathematics how often would you do any of the following? (Please check the appropriate box)

	All of the Time	Most of the Time	Some of the Time	Never
Reread				
Prepare Summaries				
Take notes				
Review				
Try to find an easier description				
Use a dictionary				
Answer study questions				

Other (Please describe) _____

_____

When reading for English classes how often would do any of the following? (Please check the appropriate box)

	All of the Time	Most of the Time	Some of the Time	Never
Reread				
Prepare summaries				
Take Notes				
Review				
Try to find an easier description				
Use a Dictionary				
Answer study questions				

Other (Please describe) _____

_____

In science, how often would you do any of the following? (Please check appropriate box)

	All of the Time	Most of the Time	Some of the Time	Never
Reread				
Prepare summaries				
Take notes				
Review				
Try to find an easier description				
Use a dictionary				
Answer study questions.				

Other (Please describe) _____

Table A3. Regression coefficients for Relevant and Incidental Posttest.

	Posttest Relevant	Posttest Incidental
Main Review (T1)	2.28	1.11
Alternate Review (T2)	1.12	-1.53
Read Only (T3)	-1.59	- .16
Pretest (Pre)	.568	.388
Worry (W)	-.207	-.160
Pre X T1	-.23	-.068
Pre X T2	.154	.108
Pre X T3	-.023	.049
Pre X W	.023	.008
W X T1	.027	.037
W X T2	.024	-.033
W X T3	.016	.094
Pre X W X T1	.014	-.005
Pre X W X T2	-.119	-.068
Pre X W X T3	.024	.042
Constant	11.85	9.15

		Mean	SD
Transformed Means and Standard Deviations:	Pretest	-.04	5.1
	Worry	.03	4.54

Table A 4. Regression coefficients of all experimental effects on macroprocessing options.

	Main Text Reviews	Alternate Text Reviews	No. of Sentences Alternate Review	Notes	Review of Notes	Options Menu
Main Review (T1)	89.81	-2.93	4.34	-2.51	-.49	.408
Alternate Review (T2)	-9.59	117.47	8.24	-1.73	-.33	-.469
Read Only (T3)	3.09	-1.60	-.58	.68	.47	.743
Pretest (Pre)	.33	-.19	-1.33	.003	-.009	.19
Worry (W)	-.85	-.57	-1.71	-.176	-.088	-.003
Pre X T1	-2.47	.54	3.49	.59	.048	-.178
Pre X T2	-.07	-1.86	5.23	.29	.100	-.279
Pre X T3	.65	-.23	-1.32	.02	.066	-.07
Pre X W	-.042	.012	.096	.04	.003	-.008
W X T1	3.87	.966	-2.65	- .08	-.028	-.156
W X T2	.99	6.54	3.74	.38	.152	-.07
W X T3	.58	.44	-.83	.85	.203	.099
Pre X W X T1	.164	-.03	-.43	-.134	-.027	-.039
Pre X W X T2	.03	.40	-.19	-.136	-.028	-.013
Pre X W X T3	-.097	-.17	-.37	-.185	-.030	-.001
Constant	12.75	6.01	21.48	7.76	.82	1.05

		Mean	SD
Transformed Means and Standard Deviations:	Pretest	.004	5.12
	Worry	.007	4.09